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Studies on storage stability of aonla (*Emblica officinalis* Gaertn.) fruit pulp

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Abstract
Diluted aonla pulp treated with 500, 1000 and 1500 ppm of sulphur dioxide was filled in glass bottles. The bottled pulps samples as such and after in bottle pasteurization were kept at ambient conditions for the storage studies. Results indicated that sulphited samples (500 ppm SO_2) with and without pasteurization remained acceptable up to four and three months, respectively while all the other samples were found acceptable even after nine months of storage.

Keywords: Studies, stability, *Emblica officinalis* Gaertn, Diluted

Introduction
Aonla (*Emblica officinalis* Gaertn.) also known as 'Indian gooseberry' occupies an important place among the indigenous fruits of India. Aonla fruit has great medicinal values and is regarded as sacred by Hindus. It is highly nutritive and is the richest source of vitamin C among the fruits except Barbados cherry. Aonla fruit is not consumed as such in fresh form because it is unfit as a dessert fruit on account of its acridity, sour taste and hard flesh.
As a consequence the fruit has been utilized to develop several value added products like ready - to - serve beverage, nectar (Ram, 1984) [17], murabba, pickles, candy, herbal squash, herbal jam, shreds, sauce and fruit toffee (Singh, 1997) [21, 24]. Aonla is a perishable produce. Therefore it is essential to extend its shelf life for prolonging the supply to the processing industry so that commercial utilization of this fruit could be established. One such alternative may be the preservation of aonla in the form of pulp as an intermediate product that can be used in preparation of variety of products. Several researchers have successfully preserved fruit pulp of mango, banana and guava by employing potassium metabisulphite (KMS) (Amba Dan and Ádsule, 1979; Diaz Delgado and Villalobos Cruz, 1974; Garcia *et al*., 1985; Guerrero, 1996; Kalra, 1982; Kalra and Tandon, 1985; Mikki and Anand, 1979) [1, 2, 4, 5, 7, 8, 14, 23]. The present investigation was therefore, conducted to study the storage characteristics of sulphited aonla pulp.

Materials and Methods
Mature aonla fruits (Var NA- 6), procured from Horticulture Nursery, Archarya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya were brought to the laboratory and converted into pulp as follows.

Pulp extraction
Fruits after thoroughly washing in tap water were subjected to thermal softening in boiling water (fruit to water ratio 1:4) till the fruit segments began to separate. Stones were removed manually and the segments were ground to a fine paste in mixer grinder using equal amount of water. The diluted pulp thus obtained was adjusted to pH 4.5 with the addition of citric acid.

Pulp treatment and storage
The diluted pulp following incorporation with KMS at the rate of 500, 1000 and 1500 of SO_2 was immediately filled in sterilized glass bottles of capacity 750 ml. The bottles were crown corked. The bottled pulp samples as such and after in- bottle pasteurization in boiling water for 20 min were kept at ambient conditions for the storage studies up to nine months.

Analysis

Bottles were opened at an interval of three months and the stored pulp samples were subjected to chemical analysis. Total soluble solids (TSS) content was determined by hand refractometer. Acidity (as anhydrous citric acid) and ascorbic acid were estimated by titration against 0.1 N NaOH and 2,6-dichloro phenol indophenol dye solutions, respectively (Ranganna, 1986) [18]. Sugars and total phenols were determined by Lane and Eynon (1923) [10] and, Swain and Hillis (1959) [22] methods, respectively. Free SO_2 was estimated by the modified Ripper titration method (Ranganna, 1986) [18]. The level of non-enzymic browning was assessed by the method as described by Ranganna (1986) [18].

Sensory evaluation

Samples were evaluated organoleptically by a panel consisting of seven members. The samples were rated on the 9 point Hedonic Rating Scale where 1 and 9 represented disliked extremely and liked extremely, respectively (Larmond, 1982) [11].

Statistical analysis

Data of sensory quality were analyzed statistically by the technique of analysis of variance (ANOVA) as described by Raghuramulu *et al.*, (1983) [16].

Results and Discussion

Data presented in Table - 1 indicates that all the samples were acceptable even after nine months of storage except T_1 and PT_1 which were acceptable up to 3 and 4 months, respectively and thereafter they were discarded due to watery separation. Possibly this was due to fermentation of pulp however, changes in colour and odour were not detected at this stage. Statistically, storage did not affect the organoleptic score significantly. Tripathi *et al.*, (1988) [24] also noted similar observations during storage of aonla juice.

Table 1: Organoleptic score of Sulphite treated aonla pulp during storage

Storage period (Months)	Organoleptic score of pulp samples					
	T_1	T_2	T_3	PT_1	PT_2	PT_3
0	8.83	8.66	8.17	8.66	8.50	8.33
3	7.66	8.50	8.50	7.66	8.33	8.17
6	-	8.17	8.17	-	8.14	8.0
9	-	7.80	7.66	-	7.71	7.71
C.D. at 5%	NS[d]	NS	NS	NS	NS	NS

Average of duplicate experiments.
T_1, T_2, T_3 Stand for 500, 1000 and 1500 ppm of SO_2,
P stands for pasteurized samples,
NS stands for non-significant.

Data presented in Table - 2 reveals that there is slight decrease in the TSS content of all the pulp samples due to storage whereas acidity, reducing sugars and total sugars recorded slight increase during the storage and non-reducing sugars with small changes followed no specific trend. Similar findings were also observed in sulphited mango (Kalra and Tandon, 1985) [7, 8, 23], peach and apricot (Shah and Bains, 1992) [20] and guava (Tandon *et al.*, 1983) [8, 23] pulp during storage. Kertesz (1951) [9] reported that degradation of pectic substances leads to increase in the titrable acidity during storage. Increase in sugars might be due to breakdown of hemicellulose and other soluble saccharides as also suggested by earlier workers (Kalra and Revathi, 1981) [7, 8, 23]. Increase in reducing sugars during storage of sulphited fruit pulp has also been noticed by other workers (Kalra and Tandon, 1985; Sethi, 1985) [7, 8, 23].

Table 2: Chemical characteristics of sulphite treated aonla pulp during storage

Storage period (Months)	Treatment					
	T_1	T_2	T_3	PT_1	PT_2	PT_3
Total soluble solids (%)						
0	5.93	5.93	5.93	5.93	5.93	5.93
3	5.75	5.81	5.83	5.76	5.82	5.81
6	-	5.54	5.53	-	5.55	5.51
9	-	5.38	5.15	-	5.41	5.15
Acidity (%)						
0	1.22	1.27	1.28	1.25	1.29	1.31
3	1.28	1.28	1.29	1.31	1.30	1.33
6	-	1.29	1.30	-	1.32	1.35
9	-	1.29	1.32	-	1.37	1.40
Reducing sugars (%)						
0	2.60	2.25	2.25	2.68	2.40	2.36
3	2.65	2.28	2.29	2.70	2.43	2.40
6	-	2.36	2.34	-	2.50	2.44
9	-	2.45	2.40	-	2.63	2.58
Non-reducing sugars (%)						
0	0.86	0.94	0.82	0.83	0.93	1.12
3	0.95	0.97	0.86	0.86	0.94	1.14
6	-	0.99	0.87	-	0.95	1.17
9	-	0.95	0.88	-	0.90	1.08
Total sugars (%)						
0	3.50	3.25	3.11	3.55	3.38	3.54
3	3.65	3.30	3.20	3.60	3.42	3.60
6	-	3.38	3.26	-	3.50	3.68
9	-	3.45	3.33	-	3.58	3.70

T_1, T_2, T_3 stand for 500, 1000 and 1500 ppm of SO_2. P stands for pasteurized samples.

Ascorbic acid content of all the samples declined continuously throughout the storage (Table - 3). This may possibly be due to oxidation of ascorbic acid to dehydro ascorbic acid. Previously considerable reductions in ascorbic acid content of aonla juice with or without sulphitation were observed during storage (Mehta and Rathore, 1976) [13]. Several workers have also reported similar findings during storage of sulphited pulp of other fruits (Ambadan and Adsule, 1979; Diaz Delgado and Villalobos Cruz, 1974; Kalara and Revathi, 1981; Pathak, 1988; Tandon *et al.*, 1983) [1, 2, 8, 15, 23]. Maximum vitamin retention with the use of 500 ppm of SO_2might be because of shorter storage period. The retention however, at end of nine months was enhanced with increasing level of SO_2 and that could be ascribed to the antioxidative property of SO_2 (Fennema, 1976) [3]. Improvement in retention of ascorbic acid as a result of pasteurization might be due to inactivation of ascorbic acid oxidase and/or changes in the other factors causing degradation of this vitamin on account of thermal exposure.

Table 3: Content and retention of ascorbic acid and total phenols in sulphited aonla pulp during storage

Storage period (Months)	Treatment					
	T_1	T_2	T_3	PT_1	PT_2	PT_3
Ascorbic acid (mg/100g)						
0	330.85	330.16	335.52	326.88	324.98	320.54
3	318.74	312.62	314.24	314.30	312.20	314.00
6	-	287.68	289.42	-	278.80	280.32
9	-	209.62	219.36	-	200.64	208.62
Total phenols (mg/100g)						
0	95.60	95.60	95.81	95.54	95.00	94.76
3	86.57	83.87	85.00	87.39	85.00	85.36
6	-	80.36	79.45	-	80.28	79.65
9	-	76.76	75.02	-	76.17	76.60

Average of duplicate experiments. Figures in parenthesis indicate per cent retention. T_1, T_2, T_3 Stand for 500, 1000 and 1500 ppm of SO_2. P stands for pasteurized samples.

Total phenols exhibited declining trend during storage (Table-3). Retention of phenols was minimum with 500 ppm SO_2 while it enhanced with raising the level of sulphitation. However, phenolics retention was almost similar in pasteurized as well as unpasteurized samples. These finding are also in agreement with earlier observations (Shah and Bains, 1992; Tandon *et al.*, 1983) [8, 20, 23].

Browning of all the samples increased continuously through-outthe storage (Table-4). The extent of browning was diminished in pasteurized as well as unpasteurised pulp samples with raising the level of sulphitation. However, browning was more in pasteurized samples than in unpasteurized counterparts. Beneficial effects of KMS in retarding browning reaction have also been reported by earlier workers (Garcia *et al.*, 1985; Main *et al.*, 1984; Pathak, 1988; Sethi, 1985) [4, 12, 15].

Table 4: Non-enzymic browning of sulphited aonla pulp during storage

Storage period (Months)	Non-enzymic browning (OD at 440 nm)					
	T_1	T_2	T_3	PT_1	PT_2	PT_3
0	0.022	0.022	0.022	0.024	0.024	0.024
3	0.068	0.039	0.026	0.065	0.036	0.038
6	-	0.054	0.050	-	0.067	0.069
9	-	0.073	0.082	-	0.096	0.094

Average of duplicate experiments. T_1, T_2, T_3 Stand for 500, 1000 and 1500 ppm of SO_2. P stands for pasteurized samples.

It may be concluded from the present study that diluted aonla pulp treated with 1000 or 1500 ppm of SO_2 could be preserved in glass bottles with or without pasteurization for $2 \geq 9$ months however additional work is needed to be done pertaining to the utilization of the preserved pulp samples.

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